



**FIVE-YEAR REVIEW REPORT FOR
UPJOHN MANUFACTURING COMPANY SUPERFUND SITE
ARECIBO, PUERTO RICO**



Prepared by

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Region II

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Date

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List of Abbreviation

| | |
|-------|---|
| CIC | Community Involvement Coordinator |
| DNAPL | Dense Non-aqueous Phase Liquid |
| EPA | United States Environmental Protection Agency |
| ESD | Explanation of Significant Differences |
| GPM | Gallons per Minute |
| ITP | Initial Testing Program |
| MBR | Mass Balance Report |
| MCL | Maximum Contaminant Level |
| µg/l | Micrograms per Liter |
| NPL | National Priorities List |
| OSWER | Office of Solid Waste and Emergency Response |
| PRASA | Puerto Rico Aqueduct and Sewer Authority |
| RA | Remedial Action |
| RCRA | Resource Conservation and Recovery Act |
| RD | Remedial Design |
| RI/FS | Remedial Investigation/Feasibility Study |
| ROD | Record of Decision |
| RPM | Remedial Project Manager |
| SAMP | Sampling, Analysis and Monitoring Plan |
| SVE | Soil Vapor Extraction |
| TI | Technical Impracticability |

Executive Summary

This is the fifth Five-Year Review for the Upjohn Manufacturing Company Superfund Site (Site) located in the Arecibo, Puerto Rico. The remedy for the Site includes extraction and treatment of contaminated groundwater. Because the remedial action for groundwater requires more than five years to completion, this Five-Year Review is being conducted as a statutory requirement. The triggering action for this policy review was the completion of the fifth (5th) Five-Year Review for the Site on September 25, 2008.

The community received their drinking water by a public water source that meets appropriate Federal and State drinking water standards and exposure to contaminated drinking water has been interrupted. The results of this Five-Year Review find that the immediate threats from the Site have been addressed, the remedies are protective, and the groundwater cleanup goals are expected to be achieved through continued treatment of contaminated groundwater.

Five-Year Review Summary Form

SITE IDENTIFICATION

Site Name: Upjohn Manufacturing Company

EPA ID: PRD980301154

Region: 2

State: PR

City/County: Arecibo

SITE STATUS

NPL Status: Final

Multiple OUs?

No

Has the site achieved construction completion?

Yes

REVIEW STATUS

Lead agency: EPA

Author name (Federal or State Project Manager): Adalberto Bosque

Author affiliation: EPA

Review period: 2008-09-15 - 2013-09-15

Date of site inspection: 2013-04-09

Type of review: Statutory

Review number: 5

Triggering action date: 2008-09-25

Due date (*five years after triggering action date*): 2013-09-25

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:

01

Issues and Recommendations Identified in the Five-Year Review:

OU(s):

Issue Category: No Issue

Issue: NA

Recommendation: NA

| Affect Current Protectiveness | Affect Future Protectiveness | Implementing Party | Oversight Party | Milestone Date |
|--|---|-------------------------------|----------------------------|-----------------------|
| NA | NA | NA | NA | NA |

Protectiveness Statement(s)

Operable Unit:
01

Protectiveness Determination:
Protective

Addendum Due Date
(if applicable):
NA

Protectiveness Statement:

The remedy at the Upjohn Manufacturing Company site is protective of human health and the environment.

Sitewide Protectiveness Statement (if applicable)

Protectiveness Determination:
Protective

*Addendum Due Date (if
applicable):*
NA

Protectiveness Statement:

The remedy at the Upjohn Manufacturing Company site is protective of human health and the environment.

I Introduction

This Five-Year Review was conducted in accordance with the Comprehensive Five-Year Review Guidance, OSWER Directive 9355.7-03B-P (June 2001). The purpose of a Five-Year Review is to evaluate the implementation and performance of a remedy in order to determine if the remedy functions as intended by the site decision documents and protects human health and the environment. This document will become part of the site file.

This is the fifth (5th) Five-Year Review for the Upjohn Manufacturing Company Superfund site located in Arecibo, Puerto Rico. Previous five-year reviews were completed at the site because contaminants remain on-site, in the groundwater above levels that allow for unrestricted use and unlimited exposure. The trigger for this Five-Year Review is the date of the previous Five-Year Review in September 25, 2008.

II Site Chronology

Table 1 (attached) summarizes the site-related events from discovery to the previous five-year review for the site.

III Background

Physical Characteristics

The Superfund site is the groundwater plume of carbon tetrachloride contamination which originated from the Upjohn Manufacturing Company. Above the plume is a former pharmaceutical facility regulated by the Resource Conservation and Recovery Act (RCRA) which was owned by Pfizer Pharmaceuticals LLC Arecibo Operations (Pfizer). The former Upjohn (Pfizer) facility closed its manufacturing operations on October 2008. In 2009, Pfizer sold the property to Global Commodity Group, with Pfizer retaining property access rights to continue its remediation obligations under the Consent Orders with Upjohn. In 2010, Pfizer closed all RCRA Operable Units (e.g. RCRA tanks, piping, Distillation Column & Container Storage Area) in accordance with an EPA-approved Closure Plan. The site is currently unoccupied.

Geology/Hydrogeology

The site is in the north coast limestone region of Puerto Rico, which is a tropical, mature karst terrain with closed depressions, sinkholes, subsurface conduits and an absence of surface water bodies. The five-mile wide coastal plain slopes gradually down to the north. Small hills known as mogotes surround the site. Blanket sands fill the valleys between the mogotes at depths ranging from approximately 3 feet to greater than 100 feet. Below the site, the Aymamon and Aguada formations, together approximately 1,800 feet thick, comprise the unconfined aquifer. In the vicinity of the site, groundwater within the unconfined aquifer generally flows to the north or slightly northeast, towards its discharge point in the Caño Tiburones and ultimately to the Atlantic Ocean. The water table is approximately 300 feet below ground surface at the site. Below the Aguada formation are the Cibao and the Lares formations, together approximately 2,000 to 2,600 feet thick, which comprise the confined or artesian aquifer. A wedge of salt water

in the Cibao, Aymamon and Aguada formations extends from the Atlantic Ocean towards the site and pinches out at State Road PR-2, some 800 feet from extraction well UE-1.

Land and Resource Use

The area surrounding the site is predominantly industrial and agricultural. The site is located in an industrial land on the north coast of Puerto Rico along State Road PR-2, approximately 1.6 miles west of Cruce Dávila, which is the local name for the intersection of State Roads PR-2 and 140. Across State Road PR-2 is the Merck, Sharp, and Dohme (formerly the AH Robins Company) pharmaceutical facility and the Tiburones residential community. The nearest residence is about 0.5 miles to the east (and about 300 feet above) the groundwater plume. Farther to the north is the Cambalache State Forest and, approximately 3.7 miles away, the Atlantic Ocean.

History of Contamination

In mid-August 1982, Upjohn Manufacturing resumed production of the antibiotic Clindamycin at its facility in Barceloneta. Between mid-August and mid-September 1982, at least 15,300 gallons of material containing approximately 65% carbon tetrachloride and 35% acetonitrile leaked from an underground storage tank in a tank farm at the site. Inspection of the failed tank revealed corrosion holes in at least three locations and inspection of the other tanks indicated possible leakage prior to 1982.

Initial Response

In response to the release, Upjohn took several early actions. Upjohn provided temporary, and ultimately permanent, alternative water supplies to the users of local water supply wells, Garrochales #1 and #2, Tiburones, and Hillside Motel, that were shut down due to the presence of carbon tetrachloride or the threat of contamination resulting from the release. Upjohn also began pumping the nearby AH Robins well as an extraction well. In 1983, Upjohn installed extraction well UE-1, covered the tank farm area with a concrete pad to prevent rainwater infiltration, and installed a soil vacuum extraction (SVE) system to remove carbon tetrachloride vapors from the unsaturated soil. Pumping of the AH Robins well was discontinued in 1985 because of the greater effectiveness of the UE-1 well. The SVE system operated until 1988, when carbon tetrachloride was no longer detected in the extracted vapors. Since 1983, extraction well UE-1 has continued to pump contaminated groundwater, which is treated by air stripping at an aeration tower, and disposed of through an existing sinkhole on-site.

The site was proposed for inclusion on the Superfund National Priorities List (NPL) in September 1983 and was listed in September 1984. In 1987, EPA and Upjohn entered into an Administrative Order on Consent (Index No. II CERCLA-106 and 122-70301), in which Upjohn agreed to, among other things, perform a Remedial Investigation/Feasibility Study (RI/FS) of groundwater contamination at the site.

Basis for Taking Action

The RI/FS was conducted to determine the nature and extent of contaminants in the groundwater at the site and to evaluate remedial alternatives. The environmental characterization is presented

in the 1987 RI. The remedial alternatives were evaluated in the 1988 FS. The 1987 RI Report identified a plume of carbon tetrachloride in the unconfined aquifer that had emanated from the tank farm towards the Atlantic Ocean. Sampling of UE-1 showed an average concentration of carbon tetrachloride in the groundwater of approximately 30 micrograms per liter ($\mu\text{g/L}$). As defined by the 5 $\mu\text{g/L}$ isopleth, the plume was approximately 0.6 miles wide and approximately 2 miles long.

The results of the risk assessment indicate that chronic ingestion of the groundwater contaminated with carbon tetrachloride would result in carcinogenic risks to residents that ranged from 2.3×10^{-4} at the AH Robbins Well to 5.8×10^{-5} at the Cano Tiburones. Plant workers may have risks of 1.6×10^{-5} from inhalation of volatiles from the on-site air stripper under specific conditions.

Risks exceeding a noncancer Hazard Quotient (HQ) = 1 were identified for children living in the area ingesting groundwater affected by the site. For adults, the noncancer HQ would be exceeded from ingestion of groundwater at the AH Robbins wells.

Maximum groundwater concentrations of CCl_4 , found during the RI, were compared to the lowest observed effects levels (LOEL) for freshwater and salt water to evaluate impacts of contaminated groundwater discharging to the Can Tiburones. Groundwater concentrations were below the LOEL and it was determined that impacts to aquatic life were expected to be low.

IV Remedial Actions

The basis for EPA's clean-up decision is documented in its September 30, 1988 Record of Decision (ROD) for the site. In April 1989, EPA issued an Explanation of Significant Differences (ESD) to clarify one requirement of the ROD, as discussed below.

Remedial Action Objectives

The overall goal of the cleanup action at the UMC site is to restore the groundwater to its beneficial uses (or health based levels) within a reasonable period of time. However, at the time of the remedy, the EPA was unable to select a restoration remedy that it could say with confidence will achieve this goal, because of the unavailability of sufficient information to determine how long it will take to restore the aquifer. Therefore, EPA selected an interim remedy. The purpose of this interim remedy is to:

- Reduce contaminant concentrations and maximize removal of contaminant mass, and
- Determine the feasibility of restoring all or portions of the aquifer to health-based levels.

Selected Remedy

The 1988 ROD selected the following remedy:

- Continued pumpage of the groundwater extraction well UE-1 at 840 gpm with treatment of the groundwater to levels no greater than 5 ppm for CCl₄ by an upgraded air-stripping system and discharge to an existing sinkhole located northwest of the UMC facility;
- Pumpage of the AH Robins well at 450 gpm plus the installation and pumpage of two new extraction wells each at 800 gpm, with treatment of the groundwater to levels no greater than 5 ppb of CCl₄ by the UE-1 air-stripping system and discharge to the existing sinkhole;
- Continued pumpage of the Garrochales #3 public supply well at 2000 gpm with treatment of the groundwater to levels no greater than 5 ppb of CCl₄ by air-stripping and subsequent distribution to the public water supply system. During remedial design, an evaluation will be made of replacing treated water from the Garrochales #3 well with alternate water supply from the artesian aquifer. Since the pumpage of the Garrochales #3 well is not an integral part of the remedial scheme, this well may be taken out of service if an artesian well is installed;
- If the two new extraction wells prove to be effective at removing contaminants from the aquifer, additional extraction wells will be added in a phased approach with treatment by air stripping and recharge to the groundwater. It is estimated that two to four additional wells will be installed and pumped at approximately 800 gpm;
- Installation of chloride monitoring wells near the coastline to monitor potential salt-water encroachment; and
- Long-term monitoring of groundwater to track contaminant movement and assess performance of groundwater extraction wells.

An ESD, signed on April 1989, because as a result of the remedial design, it was determined that the treatment would not be conducted at Garrochales #3 public supply well. Instead, an artesian water supply well would be installed.

Remedy Implementation

On March 30, 1989, EPA issued a Unilateral Administrative Order, Index No. II CERCLA-90301, (the RD/RA Order) to Upjohn for performance of the Remedial Design (RD) and Remedial Action (RA) for the artesian water supply well and for the groundwater extraction and treatment system.

Artesian Water Supply Well (Phase I)

EPA's April 4, 1989 ESD clarified that it would require replacement of the shallow Garrochales #3 Well with an artesian water supply well at the same location. Upjohn submitted an RD Plan that included the artesian well on August 23, 1991 and a Phase I RD Report on January 21, 1992. Both documents were approved by EPA. The Phase I RD Report and EPA's February 14, 1992 letter constituted the Phase I Construction Plan. Upjohn awarded a contract for construction of the well and drilling began in February 1992. Following successful completion of an EPA-approved Initial Testing Program (ITP) dated March 1992, the well was connected to the water distribution system. The Puerto Rico Department of Natural Resources and the Puerto Rico Department of Health gave their approvals for operation of the well in July 1995 and November 1995, respectively. On December 12, 1995, EPA issued its Start-Up Approval. The well, which is owned, operated, and maintained, by the Puerto Rico Aqueduct and Sewer Authority

(PRASA), has been operational since December 18, 1995. The shallow Garrochales #3 Well is permanently closed.

Ground Water Extraction and Treatment System (Phase II)

Pursuant to the RD/RA Order, Upjohn submitted a Sampling, Analysis, and Monitoring Plan (SAMP) on May 17, 1989 and, following receipt of EPA comments, submitted an Addendum to the SAMP on September 19, 1989. During review of the SAMP and SAMP Addendum, EPA raised concerns regarding the possibility that the contaminated aquifer might contain carbon tetrachloride as a dense nonaqueous phase liquid (DNAPL), either as free product or as residual saturation. In response to EPA's concerns, Upjohn submitted a Mass Balance Report (MBR) on March 28, 1991. In the MBR, Upjohn calculated the volume of carbon tetrachloride removed by the SVE system, the volume removed by the ground extraction and treatment system, and the volume remaining in the groundwater. The total volume was compared to the volume of carbon tetrachloride reportedly released. The MBR showed that 120% of the volume reportedly released had been recovered or was otherwise accounted for. Following review of the MBR, on May 2, 1991, EPA directed Upjohn to submit a revised SAMP. The revised SAMP was submitted on June 4, 1991 and approved by EPA on July 23, 1991. In December 1991, EPA completed a fracture trace analysis that was performed for use in siting additional groundwater monitoring and extraction wells.

In December 1992, Upjohn performed a special sampling of the groundwater monitoring wells at 25-foot intervals to obtain the data needed to determine the depths of future well screens. Based on these data, EPA determined that the additional groundwater extraction wells should be placed near the source area to minimize off-site migration of contaminated groundwater and to maximize recovery of carbon tetrachloride.

On February 5, 1993, EPA directed Upjohn to proceed with the Phase II RD, specifically to design the additional monitoring wells needed to determine the placement of the new extraction wells and to design the upgrade the air stripping system. The revised Phase II RD Plan was approved on June 18, 1993 and the Phase II RD Report was approved on September 30, 1993. The Phase II Construction Plan, as amended on November 8, 1993, was approved by EPA on December 15, 1993.

In February 1994, Upjohn began constructing the new monitoring wells and upgrading the air stripping system. A plan for testing the air stripping system was submitted in a March 1994 Initial Testing Protocol and the results were submitted in May 1996. The sampling results for the new monitoring wells and a proposal to construct a new extraction well, UE-2, were submitted in a technical memorandum, which was approved by EPA in January 1996. On March 11, 1996, Upjohn submitted construction specifications for UE-2. Upjohn awarded a contract for the installation of UE-2 in June 1996 and the contractor mobilized on-site in July 1996. Installation and development of UE-2 was completed on November 29, 1996.

Upjohn conducted pumping tests of UE-1, UE-2, and the Merck well and submitted the results to EPA in a second technical memorandum, dated November 1997. Analytical results showed no or low concentrations of carbon tetrachloride at the Merck well. Water level measurements showed that pumping UE-1 and UE-2 had a minimal effect on the Merck well. Based on this information,

EPA determined that the Merck well should not be part of the groundwater extraction and treatment system. EPA then required Upjohn to evaluate the need for an additional extraction well at another location.

On May 29, 1998, Upjohn submitted its Additional Well and Merck Water Level Anomaly Evaluation Report, which incorporated the results of operating extraction wells UE-1 and UE-2 from January through May 1998. On August 11, 1998, Upjohn submitted its Estimated Capture Zone, April 1998 and Carbon Tetrachloride Plume, March 1998 Diagrams. These reports showed that the combined pumping of wells UE-1 and UE-2 maximize the capture of the most highly contaminated groundwater from the unconfined aquifer while minimizing the potential for salt water intrusion. Based on these reports, EPA determined that there was no need for chloride monitoring wells or for an additional extraction well and, consequently, determined that construction of the groundwater extraction and treatment system was completed.

In September 1998, EPA requested Upjohn to submit an "Operations, Maintenance and Monitoring Plan" for the groundwater extraction and treatment system. The "Water Purification System Operation and Maintenance Manual" for the groundwater extraction and treatment system was submitted in December 1998. EPA approved the document in January 1999.

System Operations/Operation and Maintenance

Pfizer (successor to Pharmacia & Upjohn Company) is responsible for implementing the long-term operation and maintenance of the remedy pursuant to the terms of the RD/RA Order. The groundwater extraction and treatment system can remove and treat on the order of one million gallons per day.

During this review period, efforts have been made to optimize the groundwater extraction and treatment system. As the carbon tetrachloride groundwater plume diminishes in size, the extraction rate has been reduced accordingly. One additional reduction in the extraction rates was approved by the EPA during this period as discussed below. This is the third rate reduction, which equates to a 50% reduction from the original extraction rate. Modifications in parameters, sampling locations and sampling frequency have also been approved as part of these optimization efforts.

On August 21, 2008, Pfizer Pharmaceuticals LLC submitted to EPA the "Modification of the Operation of the Groundwater Remediation System progress Report No. 2" which summarized the results of the second (15%) flow rate reduction stage (25% combined with 1st stage) six month period from July 2007 to January 2008 for extraction wells UE-1 and UE-2. The report recommended the implementation of the third flow rate reduction stage (additional 25%) to each extraction well based on the field and analytical data obtained during that period. On July 28, 2010 EPA's provided its approval to proceed with the third flow rate reduction stage.

The groundwater remediation system continued to operate on a 25% reduction rate from February 2008 through August 2010. After EPA's approval for the third flow rate reduction stage (an additional 25% reduction), the third reduction step began on August 10, 2010. The flow rate for each well was reduced to 300 +/- 10 gallons per minute (gpm). Results of the third flow rate reduction stage (50%) period from August 2010 thru September 2011 were summarized in

the "Progress Report (No. 3) on Groundwater Remediation System Modification Step Drawdown Reduction 50% - Period from: August 2010 to September 2011" submitted on December 1, 2011. The system continues operation at this reduction stage until EPA approval of short term step-reduction test of extraction wells proposed by Pfizer on the above reference report.

On February 23, 2010 EPA provided its approval to Pfizer's January 7, 2010 and September 1, 2009 request for the revision of the Sampling, Analysis and Monitoring Plan (SAMP) for the groundwater remediation system at the Pfizer Arecibo facility (former Upjohn). At that point in time, the SAMP required daily monitoring of the Aeration Tower influent for alkalinity, hardness, pH, temperature, and conductivity. EPA approved the reduction of the monitoring frequency of the system influent to monthly for a period of six months and thereafter on a quarterly basis. The approval of the new monitoring frequency was in effect upon Pfizer's receipt of the approval letter.

In addition, EPA approved Pfizer September 1, 2009 proposal to modify the groundwater monitoring program at the site. The following wells were approved to be sampled on a semi-annual basis during the ongoing remediation activities: MW-1, MW-6, MW-9, MW-12, MW-17, MW-18, MW-301B and MW-302. Extraction wells UE-1 and UE-2 were to be monitored on a quarterly basis.

However EPA indicated in its response that following EPA's approval of the next 25% reduction in pumping rate, Pfizer will reinstitute quarterly monitoring for a one-year period. The following wells were to be monitored on a quarterly basis during pumping reduction stages: UE-1, UE-2, MW-1, MW-6, MW-9, MW-12, MW-17, MW-18, MW-301B and MW-302 (Figure 1).

As indicated in the "Progress Report No. 3 on Groundwater Remediation System Modification Step Drawdown Reduction 50%, December 2011, the quarterly monitoring results obtained for a one year period during the third reduction step, shown a general decrease in CCl_4 concentrations from baseline as observed in extraction wells UE-1 and UE-2, and monitoring wells MW-1, MW-18, and MW-302. No changes were observed in monitoring well MW-9. Some variability was observed in MW-301B from baseline. The general decrease in CCl_4 concentrations coincided with greater mass removal from the SVE (RCRA Corrective Measures) system after pulsing operations were initiated in April 2010.

In February 2010, Pfizer improvements to the Groundwater Remediation System became operational that included: an automated computerized monitoring and data collection system (with remote access and automated notification system) for groundwater extraction/treatment to optimize system operations, dedicated electrical (PREPA) feed, camera security system, solar powered lighting and selection of a full-time O&M contractor. On May 27, 2011, EPA approved Pfizer request to change groundwater analytical requirements by Method 524.2 to Method 8260B as requested on April 29, 2010 and SAMP decontamination procedures as requested on February 24, 2011.

The system was shut down for short durations during various dates from October 2008 through July 2013 due to maintenance activities of the treatment system air stripper tower, extraction well UE-1 pumping system electrical system failure, and a damaged pump.

V Progress Since Last Five-Year Review

The first, second, third and fourth Five-Year Reviews found that the remedy was in place and was protective of human health and the environment. No issues were raised in the last five-year review.

Since the last Five-Year Review, in September 2008, EPA approved the third flow rate reduction stage. The groundwater remediation system continued to operate on a 25% reduction rate from February 2008 through August 2010. The flow rate for each well was reduced to 300 +/- 10 gallons per minute (gpm). Additional monitoring has occurred since the last Five-Year Review and is discussed below.

VI Five-Year Review Process

Administrative Components

The five-year review team consisted of Adalberto Bosque, Remedial Project Manager (RPM), Diana Cutt, Hydrogeologist, Melvin Hauptman, Marian Olsen, Human Health Risk Assessor and Michael Clemetson, Ecological Risk Assessor.

Community Involvement

The EPA Community Involvement Coordinator (CICs) for the site is Brenda Reyes in San Juan, PR. Based on the level of community involvement at the time of previous Five-Year Reviews, EPA does not expect any significant public interest or comment on this review process.

Document Review

The documents, data, and information that were reviewed in completing the Five-Year Review are listed in Table 2 (attached).

Data Review

Pursuant to the ROD, as amended by the 1989 ESD, and as otherwise approved by EPA, the necessary O&M activities currently include:

- Operation, maintenance, and monitoring of the groundwater extraction and treatment system;
- Discharge of the treated water through the existing sinkhole; and
- Monitoring of the groundwater to detect changes in the plume.

O & M of the Groundwater Extraction and Treatment System

EPA requires a comprehensive monitoring program for the groundwater extraction and treatment system. Water pressure and flow rates from extraction wells UE-1 and UE-2 are measured on a daily basis. Groundwater samples from UE-1 and UE-2, the influent (AT-IN) and effluent (AT-OUT) of the aeration tower air stripping system, were collected and analyzed for carbon tetrachloride on a monthly, quarterly and semi-annual basis. Groundwater samples from the

influent (AT-IN) of the aeration tower were analyzed for total hardness and alkalinity on a quarterly and semi-annual basis. At the same time, quarterly and semi-annual field measurements of pH, temperature, conductivity and dissolved oxygen were performed at sampling points UE-1, UE-2, AT-IN, and AT-OUT. Daily measurements of total hardness, alkalinity, conductivity and temperature were recorded at AT-IN from July 2008 until December 2009. Daily measurements of dissolved oxygen were collected at AT-OUT from July 2008 until February 2010. The system is shut down periodically to allow for maintenance and repair.

The monitoring data for the groundwater extraction and treatment system were submitted to EPA in quarterly and semi-annual reports. The carbon tetrachloride data from the extraction wells were presented with historical results and generally show a decreasing trend as illustrated in Figures 2 and 3 with concentrations now reaching asymptotic levels slightly above the CCl₄ MCL of 5 ppb.

There was no significant change in concentrations in the extraction wells after the reduction in the groundwater extraction rate from 800 gpm (total) to 600 gpm (total) during this period. The highest concentration at the aeration tower influent at AT-IN was detected in April 2008 (18 µg/L) during this period. The carbon tetrachloride concentrations in the air stripper influent decreased slightly, from 11 µg/L to approximately 6 µg/L, after the reduction in pumping rate.

The effluent at AT-OUT has been consistently non-detect (i.e., below the detection level of 1 µg/l carbon tetrachloride) during year 2009, 2011 and 2012 monitoring period. According to the summary tables included in Quarterly and Semi-annual Progress Reports, carbon tetrachloride concentrations at the aeration tower effluent (AT-OUT) above the 1 µg/L detection level were detected during September 2008 (5 µg/L) and February 2010 (2 µg/L). These data show that the aeration tower is effective in treating the extracted groundwater in compliance with the cleanup standard of 5 µg/l carbon tetrachloride prior to reinjection into the aquifer via the sink hole locate within the site.

Monitoring of Ground Water Quality

In the earlier half of this review period, ten (10) monitoring wells and two production wells were sampled and analyzed on a quarterly basis for carbon tetrachloride to monitor the groundwater quality and evaluate any changes in the groundwater plume. The 10 monitoring wells are designated MW-1, MW-9, MW-18, MW-22, MW-23, MW-102, MW-204, MW-301B, MW-302 and AHR. The two production wells are designated Garrochales Artesiano and Pollera. Other monitoring wells identified as MW-16 and MW-207 has been taken out of service due to irretrievable obstructions in these wells. No samples are been collected from MW-101 since December 2005 due to inaccessibility issues with the well area.

The groundwater monitoring program was modified to semi-annual sampling events after EPA approval on February 2010 and included a reduction in the number of monitoring wells sampled. This program included monitoring wells MW-1, MW-6, MW-9, MW-12, MW-17, MW-18, MW-301B and MW-302. This program was modified to quarterly and then semi-annual events in accordance to EPA requirements for approval of the third pumping reduction step in extraction wells UE-1 and UE-2 on July 28, 2010.

On September 2011 monitoring well MW-9 was not found. A search of the well was performed on September 7 and 8, 2011. One protective post and broken concrete pad pieces were found on September 8, 2011.

The monitoring well data used to assess groundwater quality were compiled and submitted to EPA on a quarterly and semi-annual basis. Data from key monitoring well locations were presented with historical results in both tabular and graphical forms. In addition, the quarterly and semi-annual report includes a groundwater elevation contour map and a groundwater plume map.:-

Carbon tetrachloride concentrations in groundwater have declined over the review period to non-detect in all wells with the exception of MW-302 which is located between the two extraction wells. The carbon tetrachloride plume is now very dilute with a concentration of 13 ug/L at MW-302 detected in September 2012 remaining as the only exceedance of the MCL of 5 ug/L in the MWs. As shown in Figure 4 the carbon tetrachloride groundwater concentrations in this well have remained steady with slight fluctuations over the review period. The extracted concentrations are consistently less than 7 ug/L at the extraction wells indicating an asymptotic trend. The shallow Garrochales #3 water supply well, also owned by the Puerto Rico Aqueduct and Sewer Authority (PRASA) was closed on December 18, 1995 and is no longer used or monitored.

Site Inspection

The need for ongoing five-years reviews stems from the presence of carbon tetrachloride in the shallow aquifer.

A site inspection was conducted on April 9, 2013 as part of this Five-Year Review.

Interviews

No interviews were conducted for this review.

Institutional Controls

There were no institutional controls selected in the ROD. At the time of the ROD there were Commonwealth rules and regulations requiring a permit for the installation of wells. Consequently, there did not appear to be a risk that potable water wells would be installed during the period of remediation. The contaminated groundwater plume has been identified and is under control. All nearby water is provided by public water supply. The Commonwealth requirements concerning installation of wells remain in effect. There remains no need to include institutional controls as a component of the remedy at this Site.

VII Remedy Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Yes, the remedy is functioning as intended by the ROD signed on September 30, 1988.

The cleanup objective for the Upjohn Site ROD is to reduce contaminant concentrations and maximize removal of contaminant mass. Carbon tetrachloride concentrations in groundwater have declined over the review period to non-detect in all wells with the exception of MW-302 which is located between the two extraction wells. The carbon tetrachloride plume is now very dilute with the concentration of 16 ug/L at MW-302 remaining as the only exceedance of the MCL of 5 ug/L.

An objective for the ROD was also to determine the feasibility of restoring all or portions of the aquifer to health-based levels. Since the interim remedy has been operating, the groundwater plume has been reduced in size and contaminant concentration. Based on the data collected throughout the operation of the selected remedy it can be stated that restoration is practicable.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

Are the (1) exposure assumptions and toxicity data (2) used at the time of the remedy selection still valid?

Groundwater. With implementation of the remedy, the water supply of the local community is now an artesian public water supply well that meets federal drinking water standards, and ingestion of contaminated groundwater from the Site is no longer a completed exposure pathway.

Although the ecological risk assessment screening values used to support the 1988 ROD may not necessarily reflect the current values, the remedy is protective of ecological resources as the exposure to ecological receptors has been controlled by the groundwater extraction and treatment system. The only potential route of ecological exposure is if the groundwater contaminants were transported to surface water. The groundwater discharges into a wetland (Caño Tiburones) approximately 3 miles from the site. However, the groundwater contaminant plume is contained within the site boundary. Therefore, the remedy appears to adequately protect ecological receptors by preventing discharge to the Cano Tiburones.

Review of the Quarterly and Semi-annual Monitoring Reports from 2008 to 2012 indicates variability in the concentrations of carbon tetrachloride based on well locations. Concentrations in wells MW-1 and MW-18, (2008 to 2013), MW-22, MW-23, MW-102 and MW-204 (2008 to 2009), MW-9 (2008 to 2011), and MW-6, MW-12 and MW-17 (2010 to 2013), are below the CCl₄ MCL of 5 µg/l. Concentrations in wells MW-301B showed a range of concentrations from non-detect to 8.9 µg/l. All samples results in this well with the exception of the sample collected in March 2011 were all below the CCl₄ MCL of 5 µg/l. MW-302 showed concentrations from 13 µg/l to 35 µg/l (based on historical groundwater data tables included in Appendix 6 of the “Semi-annual Monitoring Progress Report April to September 2012, Water Purification System Operation and Maintenance, Pfizer Pharmaceuticals, LLC, (Former Pharmacia & Upjohn), Arecibo, Puerto Rico” dated October 31, 2012).

The toxicity values identified in the previous five-year review were updated through EPA’s Integrated Risk Information System program (www.epa.gov/iris). On March 31, 2010 IRIS updated the toxicity values for carbon tetrachloride including the oral Reference Dose (RfD), cancer assessment sections and the addition of an inhalation Reference Concentration (RfC).

Comparison of the concentration associated with the Maximum Contaminant Level (MCL) of 5 ug/l indicate the risks are within the risk range of 10^{-4} to 10^{-6} established under the National Contingency Plan based on a comparison of the concentration associated with a risk of 10^{-6} assuming residential exposures of 0.39 ug/l). The concentration associated with ingestion of drinking water at 5 ug/l is below a $HI = 1$ which is associated with a concentration of 40 ug/l). This comparison indicates that the MCL remains protective based on the updated toxicity information.

Vapor Intrusion. Consistent with EPA's guidance on soil vapor intrusion, significant indoor air concentrations are not expected at the site because the water table is 300 feet below the ground surface (see Section III, above). Thus, the depth to the ground water at the site is more than the 100 foot distance identified in guidance as a conservative estimate of vertical transport (November, 2002, *Draft Guidance For Evaluating the Vapor Intrusion to Indoor Air Pathway From Groundwater and Soils [Subsurface Vapor Intrusion Guidance]*, EPA 530-F-02-052).

Are the Cleanup Values Selected in the ROD Still Valid?

The 1988 ROD specified cleanup values for the treated water are still valid. The treatment level for carbon tetrachloride identified in the Record of Decision is 5 ppb (5 $\mu\text{g/l}$). The MCL for carbon tetrachloride has not changed and remains protective for residential consumption of groundwater as described above.

Are the remedial action objectives still valid?

The remedial action objectives in the interim ROD were to reduce groundwater contaminant concentrations and to assess the feasibility of restoring groundwater. These objectives are still valid. Since operational and monitoring data indicate that restoration is feasible, restoration of groundwater to beneficial use should be selected as a final remedial action objective in a remedy decision document.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Based on the evaluation of the potential human and ecological exposures at the site there is no new information that has been developed that could call into question the protectiveness of this remedy.

VIII Recommendations and Follow-Up Actions

The selected remedy is fully implemented. It includes ongoing operation, maintenance and monitoring activities as part of the selected remedy. As anticipated by the decision documents, these activities are subject to routine modification and adjustment. EPA currently is considering an additional groundwater extraction reduction and is reviewing a proposed step reduction test for the extraction wells.

IX Protectiveness Statement

The remedy at the Upjohn Manufacturing Company site is protective of human health and the environment.

X Next Review

The next Five-Year Review for the site will be completed by September 2018, five years from the date of this review.

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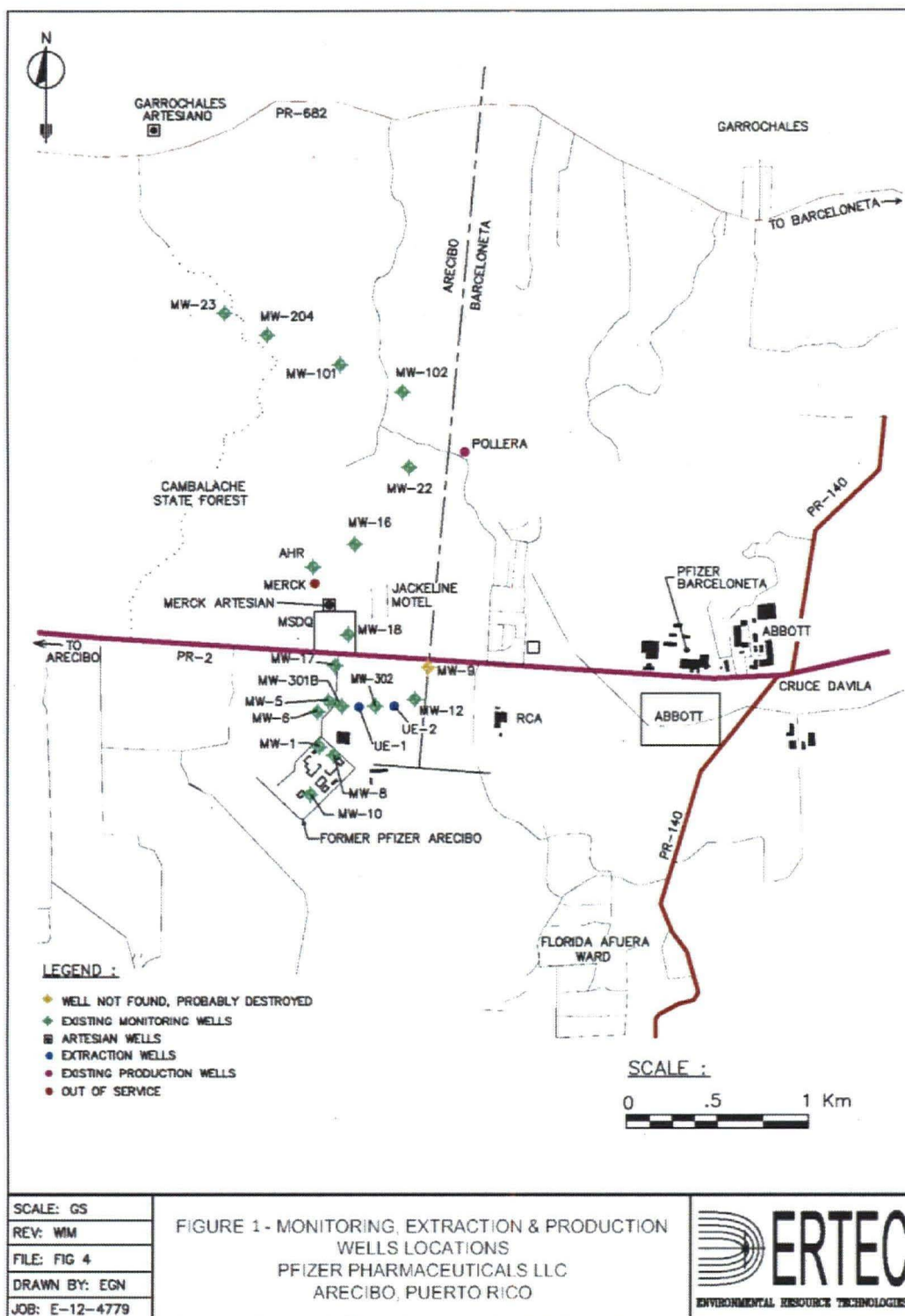


Figure 2 - Carbon Tetrachloride in Extraction Well UE-1

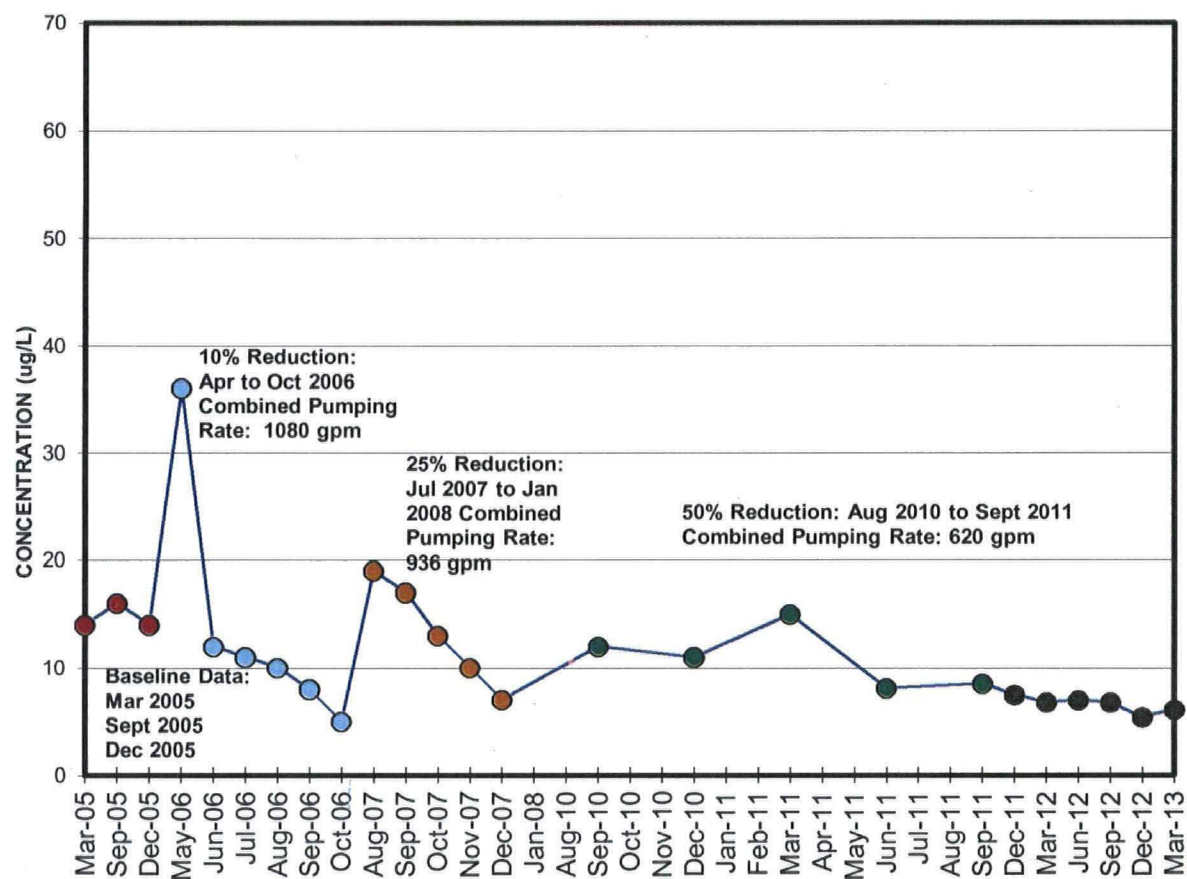


Figure 3 - Carbon Tetrachloride in Extraction Well UE-2

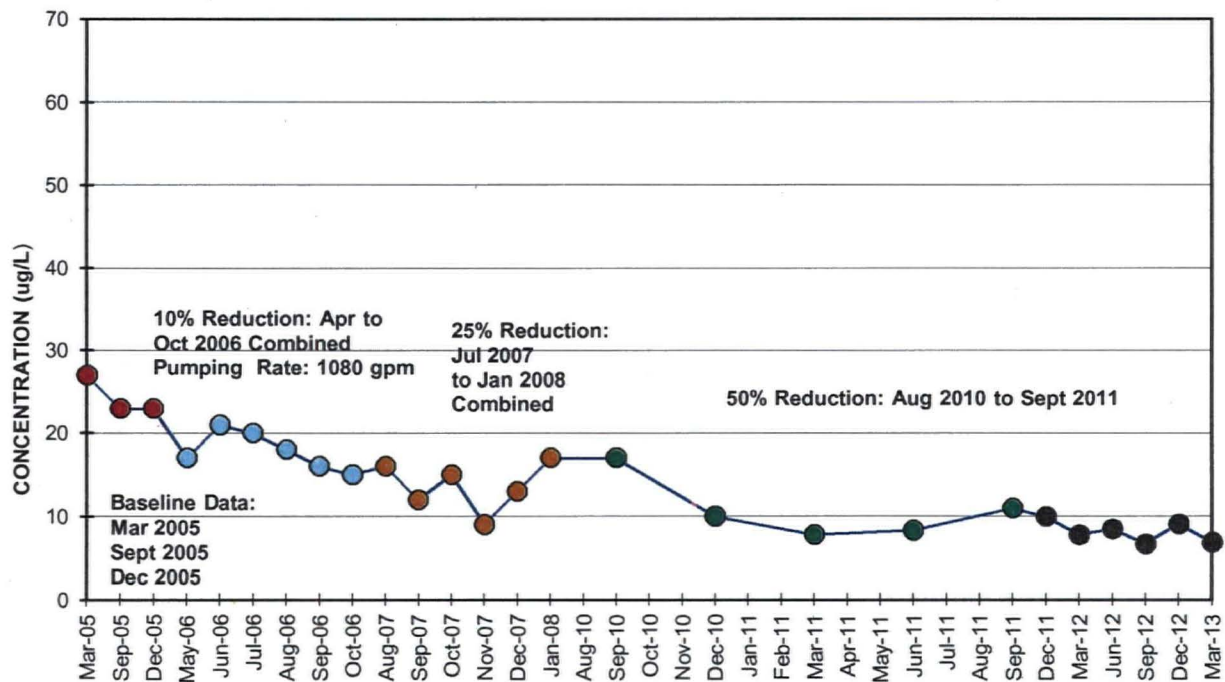


Figure 4 - Carbon Tetrachloride in MW-302

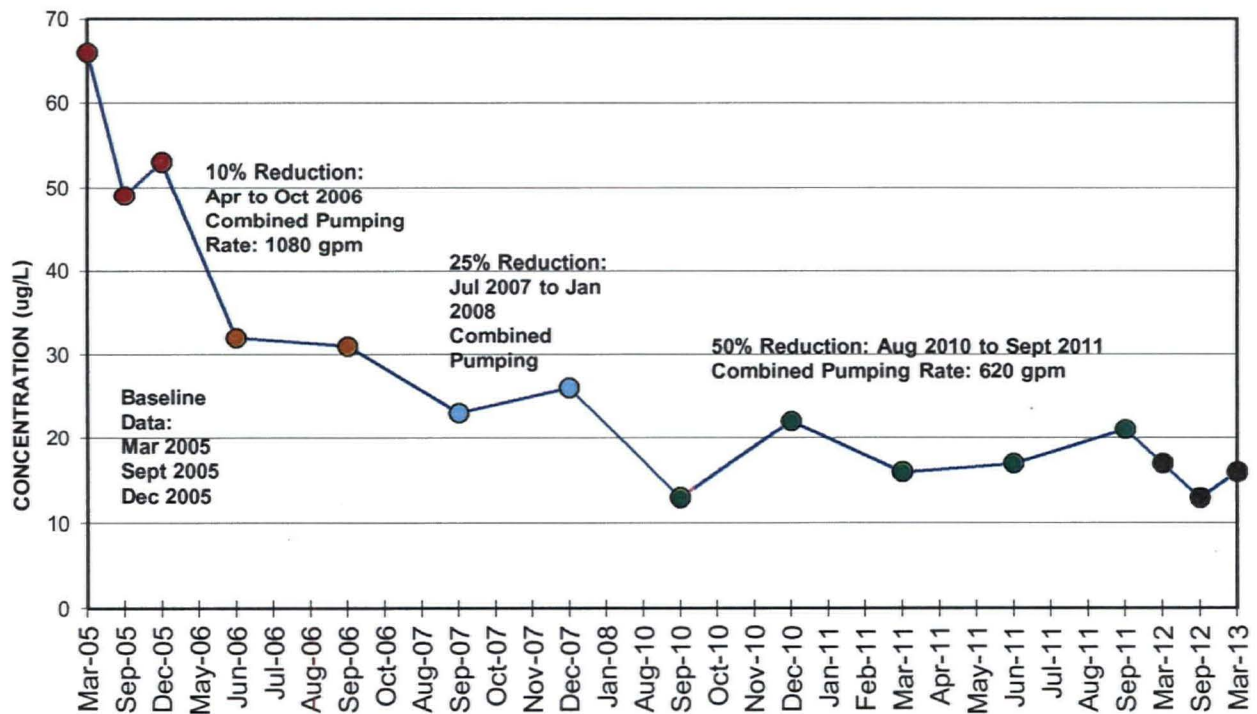


Table 1 – Chronology of Site Events

| Event | Date(s) |
|---|-----------------------------|
| Release of carbon tetrachloride from underground tank | 1982 (and possibly earlier) |
| Provision of alternative water supplies | 1982 |
| Site proposed on NPL | 1983 |
| Operation of SVE System | 1983-1988 |
| Site listed on NPL | 1984 |
| Administrative Order on Consent for Performance of Remedial Investigation and Feasibility Study, Index No. II CERCLA-106 and 122-70301, EPA | 1987 |
| Amended Remedial Investigation, Soil Tech Corp. | 1987 |
| Feasibility Study, CDM-Federal Programs Corp. | 1988 |
| Record of Decision for the Upjohn Manufacturing Company Site, EPA | 1988 |
| Unilateral Administrative Order for Performance of Remedial Design and Remedial Action, Index No. II CERCLA-90301, EPA | 1989 |
| Explanation of Significant Differences issued by EPA | 1989 |
| Sampling, Analysis, and Monitoring Plan (SAMP) and SAMP Addendum, Soil Tech Corp. | 1989 |
| Mass Balance Report, Soil Tech Corp. | March 1991 |
| Revised Sampling, Analysis, and Monitoring Plan (SAMP), Soil Tech Corp. | June 1991 |
| Remedial Design Plan | August 1991 |
| Fracture Trace Analysis, EPA | December 1991 |
| Phase I Remedial Design Report, Pedro Panzardi & Assoc. | January 1992 |
| Special Report (December 1992 Special Sampling), Soil Tech Corp. | February 1992 |
| Initial Testing Program for Garrochales Artesian Well, Soil Tech Corp. | March 1992 |
| Revised Phase II Remedial Design Plan, Pedro Panzardi & Assoc. and Soil Tech Corp. | May 1993 |
| Phase II Remedial Design Report, Pedro Panzardi & Assoc. and Soil Tech Corp. | August 1993 |
| Phase II Construction Plan, Pedro Panzardi & Assoc. and Soil Tech Corp. | October 1993 |
| Addendum to Phase II Construction Plan, Upjohn | November 1993 |
| Initial Testing Program for the Ground Water Treatment System, Pedro Panzardi & Assoc. | March 1994 |
| Professional Engineer=s Certification, Pedro Panzardi & Assoc. | January 1996 |
| Technical Memorandum I, Phase II Remedial Design Report, Soil Tech Corp. | January 1996 |
| Summary Report for the Initial Testing Program, April 1996, ERTEC | May 1996 |
| First Five-Year Review Report, EPA | November 1996 |

| Event | Date(s) |
|--|----------------|
| Technical Memorandum II, Phase II Remedial Design Report, ERTEC | November 1997 |
| Additional Well and Merck Water Level Anomaly Evaluation Report, ERTEC | May 1998 |
| Estimated Capture Zone April 1998 & Carbon Tetrachloride Plume March 1998 Diagrams, ERTEC | August 1998 |
| Preliminary Close Out Report, EPA | September 1998 |
| Second Five-Year Review Report, EPA | September 1998 |
| Remedial Action Report for ground water extraction and treatment system, Pedro Panzardi & Assoc. | December 1998 |
| Third Five-Year Review Report, EPA | September 2003 |
| Fourth Five-Year Review Report, EPA | September 2008 |

Table 2 – Documents, Data, and Information Reviewed in Completing the Five-Year Review

| Document | Date(s) |
|---|------------------|
| Administrative Order on Consent for Performance of Remedial Investigation and Feasibility Study, Index No. II CERCLA-106 and 122-70301, EPA | 1987 |
| Record of Decision for the Upjohn Manufacturing Company Site, EPA | 1988 |
| Unilateral Administrative Order for Performance of Remedial Design and Remedial Action, Index No. II CERCLA-90301, EPA | 1989 |
| Explanation of Significant Differences issued by EPA | 1989 |
| First Five-Year Review Report, EPA | November 1996 |
| Second Five-Year Review Report, EPA | September 1998 |
| Third Five-Year Review Report, EPA | September 2003 |
| Fourth Five-Year Review Report, EPA | September 2008 |
| Quarterly Monitoring Progress Reports from January-March 2008 | April 30, 2008 |
| Quarterly Monitoring Progress Reports from April- June 2008 | July 30, 2008 |
| Modification of the Operation of the Groundwater Remediation System Progress Report No. 2 | August 21, 2008 |
| Quarterly Monitoring Progress Reports from July- September 2008 | October 31, 2008 |
| Quarterly Monitoring Progress Reports from October- December 2008 | January 30, 2009 |
| Quarterly Monitoring Progress Reports from January-March 2009 | April 30, 2009 |
| Quarterly Monitoring Progress Reports from April- June 2009 | July 31, 2009 |
| Quarterly Monitoring Progress Reports from July- September 2009 | October 30, 2009 |
| Quarterly Monitoring Progress Reports from October- December 2009 | January 29, 2010 |
| Supplemental Information Requested by EPA for Pumping Step-Down Reduction | February 8, 2010 |
| Quarterly Monitoring Progress Reports from January- March 2010 | April 30, 2010 |
| Semi-annual Monitoring Progress Report (April 1 through September 30, 2010) | October 29, 2010 |
| Semi-annual Monitoring Progress Report (October 1, 2010 through March 31, 2011) | April 29, 2011 |

| Document | Date(s) |
|---|------------------|
| Semi-annual Monitoring Progress Report (April 1 through September 30, 2011) | October 28, 2011 |
| Progress Report No. 3 on Groundwater Remediation System Modification – Step Drawdown Reduction 50 %, Period from: August 2010 to September 2011 | December 1, 2011 |
| Semi-annual Monitoring Progress Report. (October 1, 2011 through March 31, 2012) | April 25, 2012 |
| Semi-annual Monitoring Progress Report. (April 1 through September 30, 2012) | October 31, 2012 |